

UNIT-3

POLLUTION

- Man made activities have caused environmental degradation such as land degradation, destroyed forests, thrown tonnes of toxic waste into rivers and poured toxic chemicals into the seas along with these we discharged green house gases into the atmosphere leading to climatic changes.
- The net result is we are surrounded by pollution in our daily lives which we breathe we drink and we eat pollution.
- There are four different kinds of pollution:-
Such as
 - a) Water pollution
 - b) Air pollution
 - c) Noise pollution
 - d) Soil pollution etc.

a) Water pollution:-

- Any change in the dynamic equilibrium in aquatic ecosystem (water body / biosphere / atmosphere) disturbs the normal function and properties of pure water and gives rise to the phenomenon of water pollution.
- The symptoms of water pollution are.
→ Bad taste of drinking water.

- Offensive smell from lakes, rivers and ocean beaches.
- Unchecked / uncontrolled growth of aquatic weeds in water bodies (Eutrophication)
- Dead fish floating on water surface in river lake etc.
- Oil and grease floating on water surface.

• Water pollutants :-
The large number of water pollutant are broadly classified under the categories

- 1) Organic pollutants
- 2) Inorganic pollutants
- 3) Sediments
- 4) Radioactive materials
- 5) Thermal pollutants

• Organic pollutants : -

- These include domestic sewage, pesticides, synthetic organic compounds, plant nutrient (from agricultural run off), oil, wastes from food processing plants, paper mills etc.
- These reduce dissolved O_2 (D-O) in aquatic life (4-6 ppm - optimum level). which is the indicator of water pollution.

- Sewage and agricultural runoff provide plant nutrients in water giving rise to the biological process known as Eutrophication.
- Large input of fertiliser and nutrient from these sources leads to enormous growth of aquatic weeds which gradually cover the entire water body (algal bloom)
- They reduce the D.O level and end up in a deep pool of water where fish can not survive.
- The presence of synthetic organic chemicals such as fuels, plastic fibres, solvents, detergents, paints, food additives, pharmaceuticals etc. in water body gives objectionable and offensive tastes, odours and colours to fish and aquatic plants.
- Oil pollution in Seas (Sea transports) reduces the light transmission through surface water and hence reduce photosynthesis by marine plants, decreases D.O. in water causing damage to Marine life (plants, phytoplankton, zooplankton, fish etc.) and also contaminates sea food which enters the human food chain.

At present there are 10,000 ^{different} pesticides in use they include insecticides (DDT), herbicides, fungicides etc.

- Pesticide residues contaminate crops and then enter the food chain of birds, mammals and human beings.
- The persistent pesticide called DDT is not degraded in the environment. It accumulates in food chain and getting magnified in each step from seaweed to fish and then man. Then in man it causes untreated / complicated diseases.

Pollutants:-

- (2) Inorganic Pollutants:-
- It consists of inorganic salts, mineral salts, acids, metals, trace elements, detergents etc.
- Through acid mine drainage such as coal mining discharge acid (H_2SO_4) and also ferrie hydroxide ($Fe(OH)_3$) into local streams through seepage. This acid on entering the waterbody destroys the aquatic life.
- (3) Sediments
- Soil erosion (due to agricultural and construction activities) generates sediments in water bodies. These sediments are the important reservoirs of inorganic and organic matter, such as trace metals like Cr, Cu, Ni, Mn, Molybdenum etc. These metals cause water pollution.

④ Radioactive Materials

- Radioactive pollution is caused by mining and processing of radioactive ores to produce radioactive substances, use of radioactive materials in nuclear power plants, use of radioactive isotopes in medical industrial and research institutes and nuclear industrial and research institutes and nuclear
- discharge of radioactive wastes into water and sewer system causes water pollution.

⑤ Thermal Pollutants

- Coal-fired or nuclear fuel-fired thermal power plants are sources of thermal pollution. The hot water generated from these plants (process) is dumped as waste into nearby lake or river where its temperature rises by about 10°C . This has a harmful effect on the aquatic life (DO is reduced).

Ground water pollution :-

- Ground water is relatively free from surface contamination (50 ft below land surface) and the surface water gets filtered or screened by the underlying layers of soil, sand and stone pieces.
- But due to leaching of minerals below the earth's surface it gets contaminated too.

- An important case of Arsenic contamination of ground water.
- Due to excessive pumping of ground water by shallow tube wells for irrigation in some West Bengal districts along with Hooghly river course and also in Bangladesh along with the Padma river course.
- During irrigation (excessive pumping) air (O_2) oxygen is injected into ground water bed which leaches the underlying mineral, iron pyrite (iron, As, sulphide) oxidizes it and releases arsenic into ground water.

Case Study of Ganga pollution

The most typical example of River Ganga pollution.

- Ganga basin provides maximum population density - many class I (100,000 and above), class II (50,000 - 100,000), class III (20,000 - 50,000) cities have grown in this region.
- Both domestic and industrial sewage join the Ganga river without any treatment and thus causes terrible pollution.

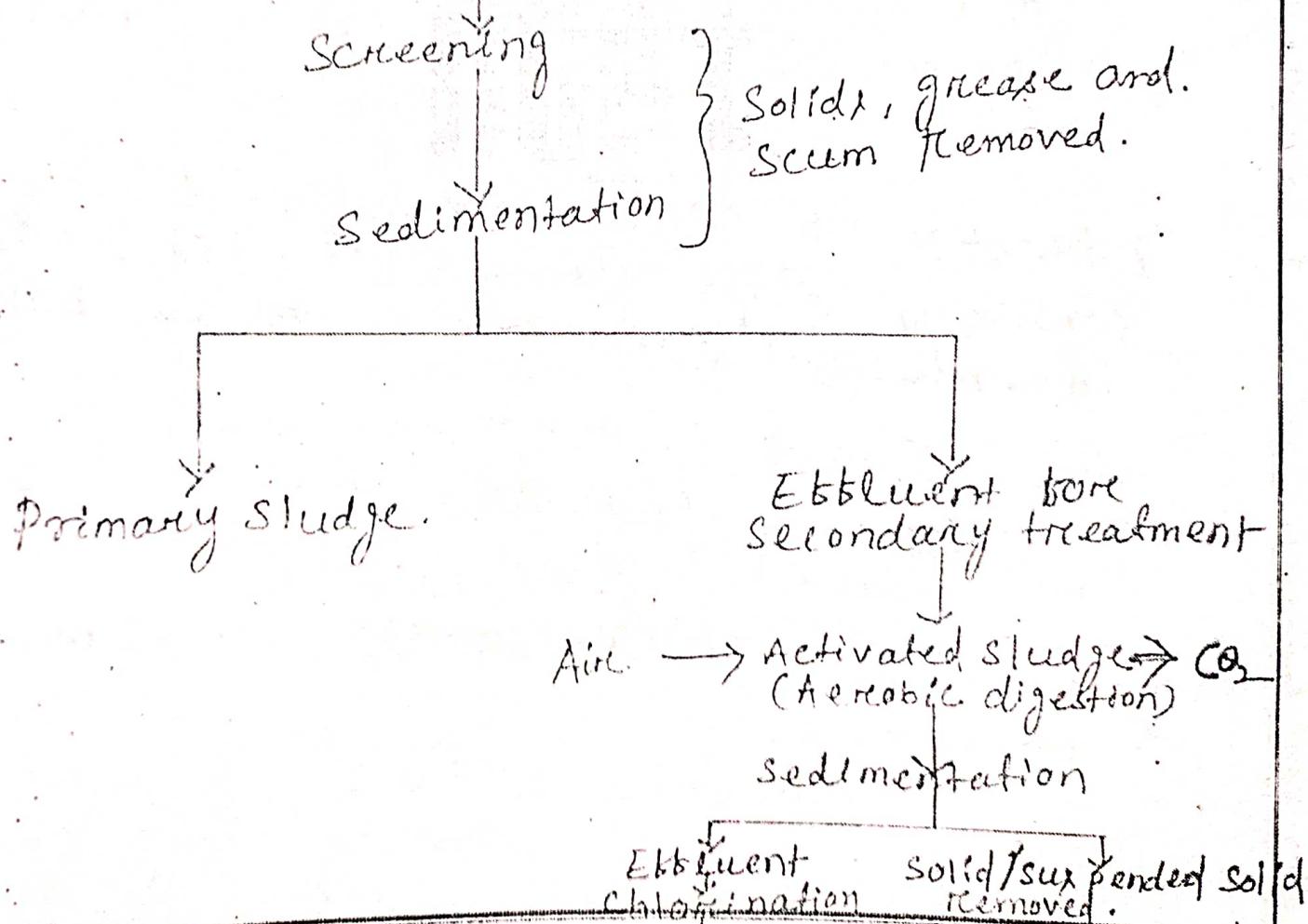
Waste water treatment

- Water pollution is caused by domestic (84%) sewage and industrial sewage (16%).
- There is less load of industrial sewage but it contains more toxic matter (inorganic and organic) which are more hazardous.

Municipal waste water treatment

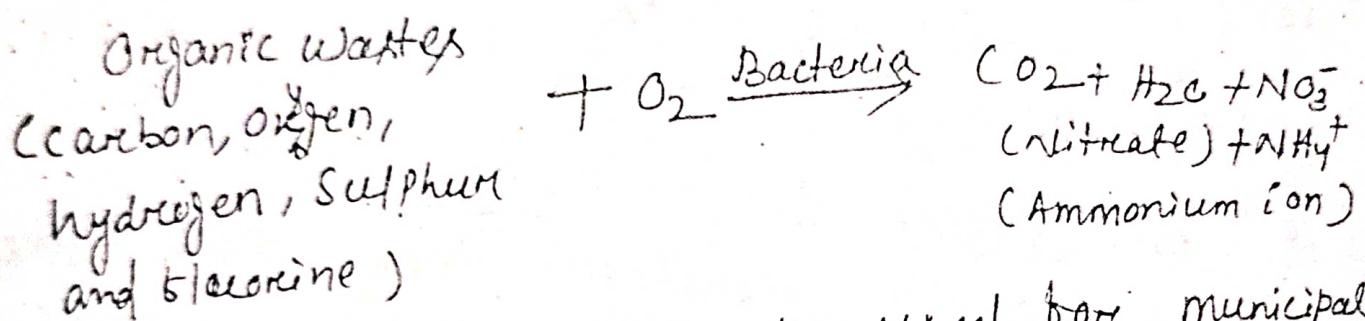
Raw waste water.

(BOD 200 ppm, NH_4^+ 30 ppm, PO_4^{2-} 25 ppm)



→ Domestic water water treatment

Sewage treatment plants, depends on biological decomposition of non-toxic organic wastes using bacteria. Such biological decomposition is carried out under aerobic conditions i.e. in presence of plenty of oxygen.



This process, commonly used for municipal

Waste water treatment:

Drinking water supply

- Treatment of drinking water supply is a matter of public health concern.
- They operate in three steps.

i) Aeration to settle suspended matter.
 ii) coagulation of small particles and suspended matter by lime and ferric chloride.

iii) Disinfection by chlorination to kill viruses, bacteria etc.

The purified water is then supplied by municipalities through pipes for domestic use.

Air Pollution:

- Pure air is colourless and odourless.
- But various pollutants from natural and man made sources are entering the atmosphere daily and disturb the dynamic equilibrium in the atmosphere. This leads to Air pollution.

Natural sources of air pollution are:-

- Volcanic activity, vegetation decay, forest fires emitting CO, Sulphur dioxide and hydrogen sulphide and tiny particles of solids or liquids sprayed from the sea and land by wind.

Man made sources are:-

- Gases, mists, particulates and aerosols emitted by industries and other chemical and biological processes used by man.

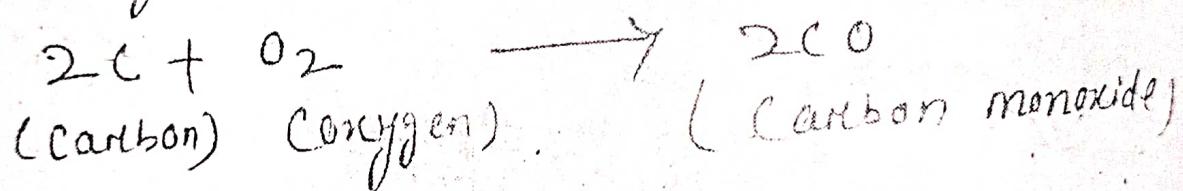
Primary Pollutants

- There are 5 primary pollutants which together contribute to more than 90% of global air pollution. These are CO, Nitrogen oxides, Hydrocarbons, Sulphur oxides, Particulates.
- Transportation accounts for more than 4%.

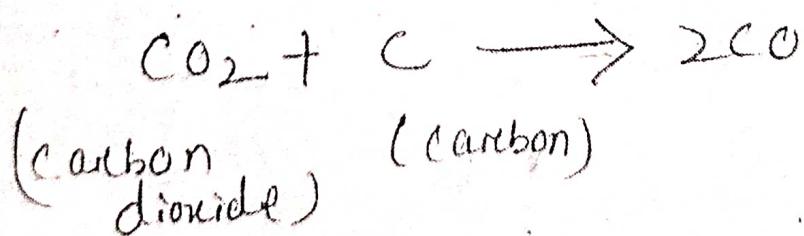
of total pollutants produced per year. Hence it is the principal source of air pollution.

Carbon monoxide (CO)

- It is a colourless, odourless and tasteless gas which is injurious to our health. Transportation accounts for 70% of CO emission.
 - The sources of carbon monoxide, CO, are the chemical reactions:
- i) incomplete combustion of fuel or carbon containing compounds -



- ii) Reaction of carbon dioxide and carbon containing materials at elevated temp. in industries. ^{for example} in blast furnaces



- iii) Dissociation of carbon dioxide at high temperature.



Sinks

Part of Carbon monoxide is lost in the upper atmosphere. The major sink is soil micro-organisms. A potting soil of weighing 28 kg can completely remove in 3 hrs 120 ppm CO from ambient air. The same soil sample on sterilization failed to remove CO from air.

Control of CO pollution:-

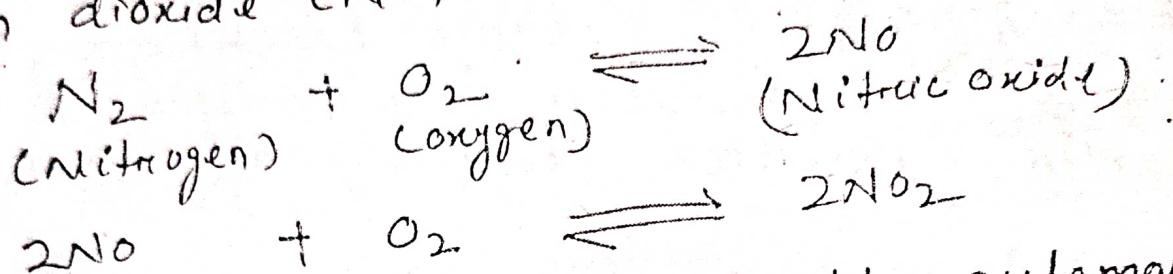
- such converters (catalytic converters) built into the automobile
- Use of Catalytic built into the automobile engines promote oxidation-reduction cycles and ensure complete combustion of CO, nitrogen oxides and hydrocarbons.
- Use of Catalytic converters in two stages helps in the elimination of pollutants from exhaust gases before they are discharged into the atmosphere.
- In the first converter, nitrogen oxides are reduced to nitrogen (+ ammonia) in the presence of finely divided catalyst platinum, and the reducing gases carbon monoxide and hydrocarbons.
- In the second converter, air is introduced to provide an oxidizing atmosphere for complete oxidation of CO and hydrocarbon into CO_2 and water in presence of finely-divided platinum catalyst.

- B. Tech I Year [Subject Name: Environment & Ecology]

 - Thus by means of platinum catalytic converters, auto-exhaust emissions are cleared up through reduction oxidation reaction.

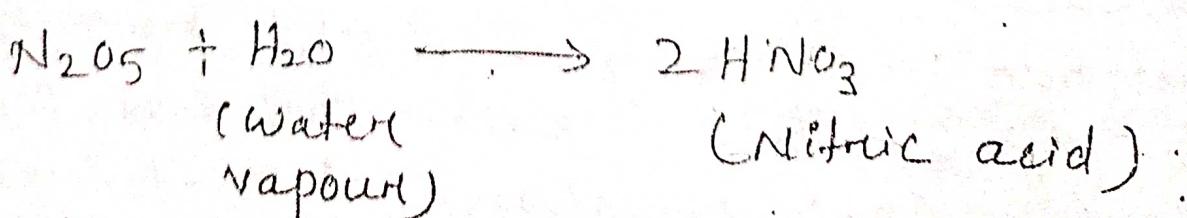
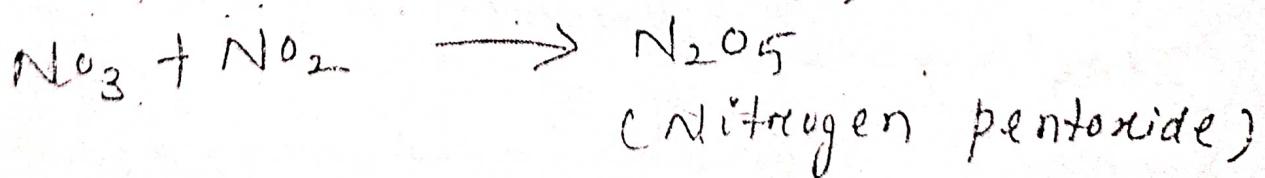
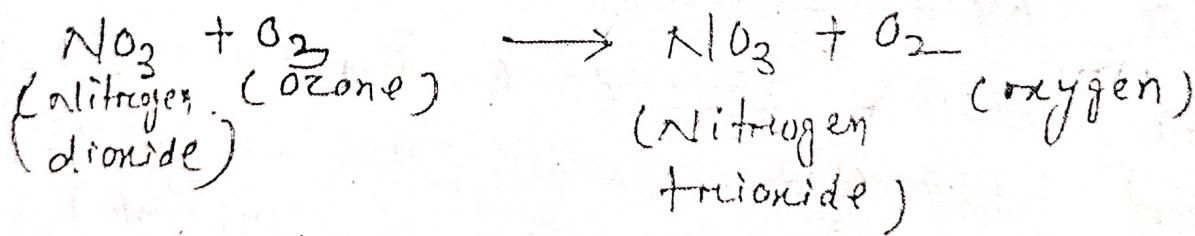
auto-exhaust reduction oxidation reaction:-
control of Nitrogen Oxides pollution:-

- Control of Nitrogen
 - It consists of mixed oxides, nitric oxide and nitrogen dioxide (NO , NO_2 etc.)



$$2\text{NO} + \text{O}_2 \xrightarrow{\quad} \text{These reactions occur inside the automobile engine so that the exhaust gases consist of Nitrogen oxides. (NOx) which is converted into nitric}$$

Nitrogen oxides (NO_x)
In air NO_x is converted into nitric
oxide (NO) by natural processes.



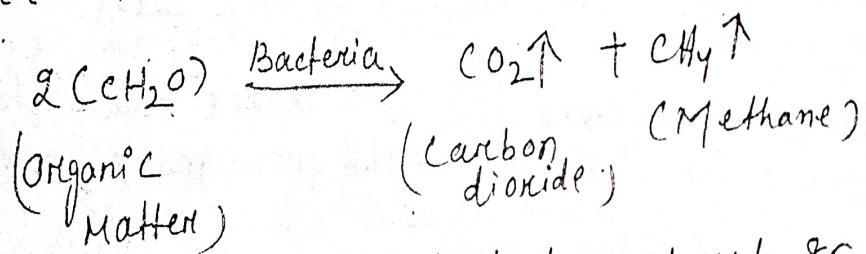
This acid rain. is one of the constituents

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Hydrocarbons and Photochemical Smog :-

- Hydrocarbons and Photochemical processes, a large quantity of hydrocarbons are emitted into air.

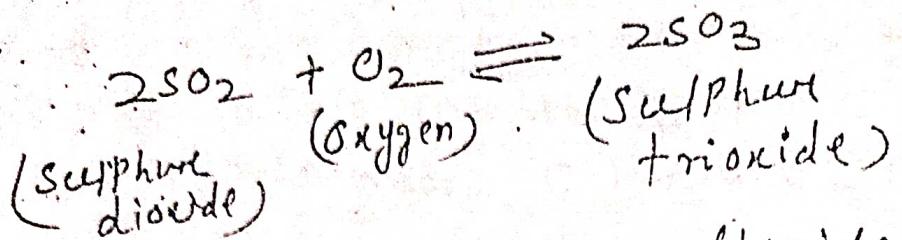
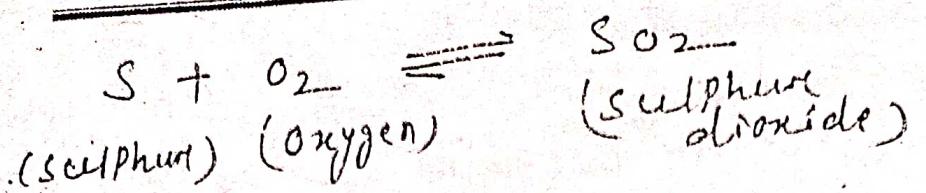
 - Methane (CH_4) is a major hydrocarbon. It is generated in large quantities by bacteria formed by anaerobic decomposition of organic matter in water, sediments and soil.



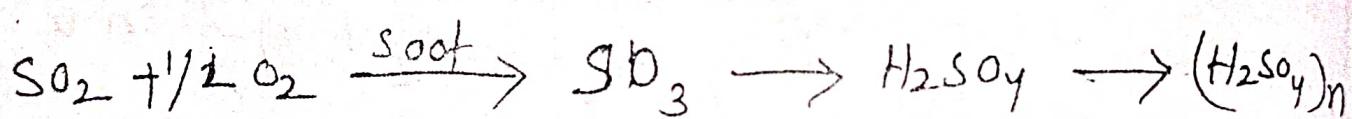
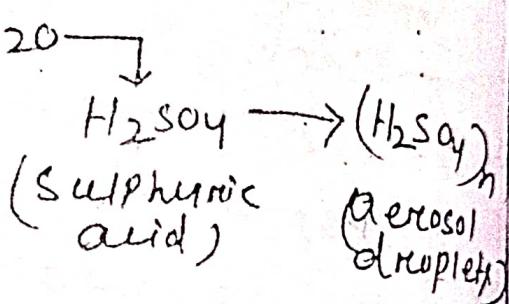
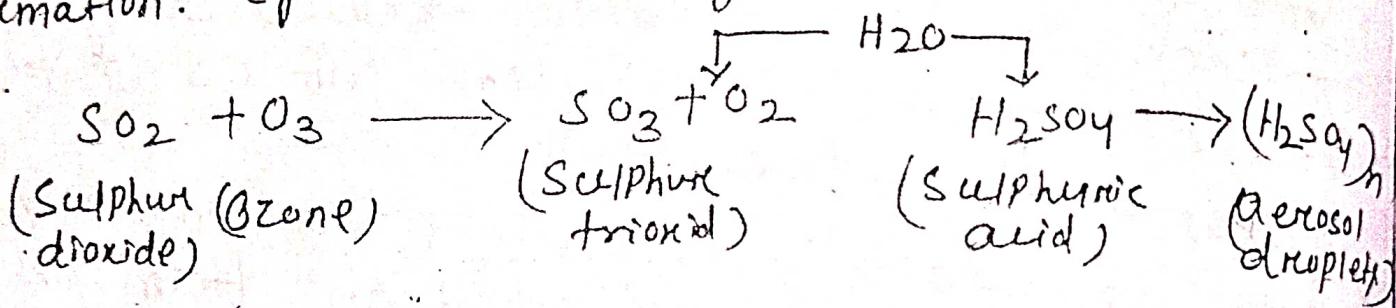
- Domestic animals contribute about 85 million tonnes of Methane to the atmosphere each year. Automobiles are the significant source of hydrocarbons
 - In presence of ozone, CO, Nitrogen oxides and hydrocarbon participate in photochemical reactions (in presence of Sunlight)

Sulphur dioxide (SO_2) :-

- Sulphur dioxide is produced from the combustion of any sulphur bearing material. Sulphur dioxide (SO_2) is always associated with a little of sulphur trioxide (SO_3).

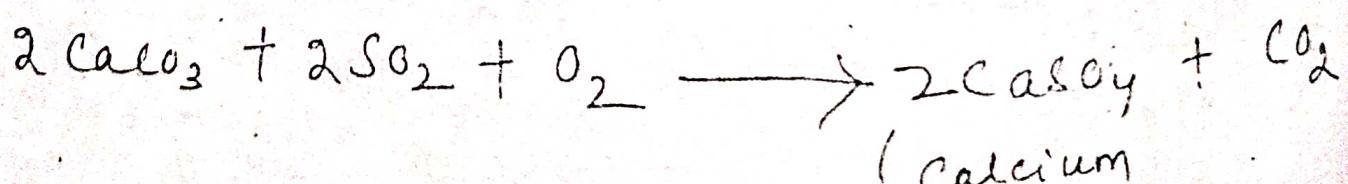


In winter sulphur dioxides from thermal power plants along with other gases lead to smog formation. e.g. London smog.



(soot particles contain metal oxides catalyze the oxidation of SO_2 to SO_3)

SO_x (sulphur oxides) from blue gases of industrial plants can be removed by means of chemical scrubbers.



(Calcium sulphate)

This method is economical but the disposal of solid waste, Calcium Sulphate is a problem.

Acid Rain

Acid Rain can be checked if its constituents Sulphur Oxide and Nitrogen Oxide will be controlled.

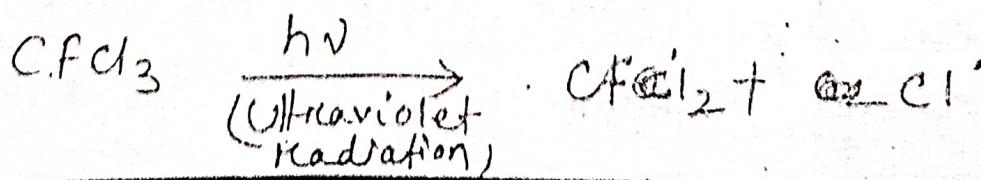
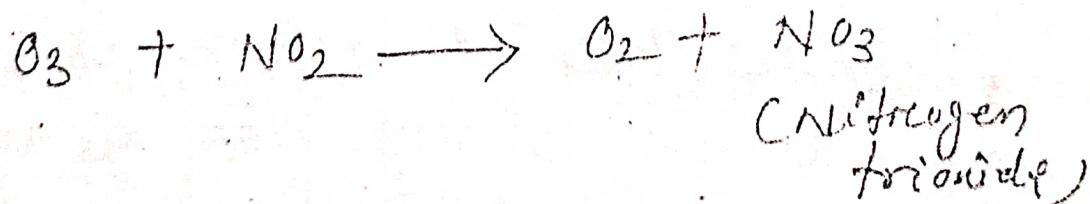
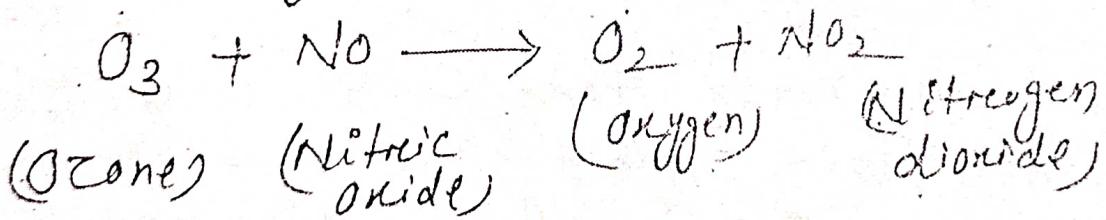
articulate Matter

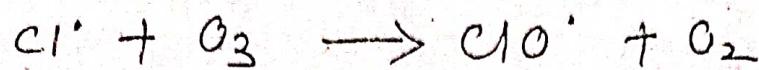
Particulate Matter: Small solid particles and liquid droplets are called particulates. They originate both from

natural and man made sources.

Ozone Hole

- Ozone acts as a protective shield for earth.
- It strongly absorbs UV radiation from the earth sun (295-320 nm) which is injurious to life on earth.
- Thus it protects living species on earth.
- Recent human activities have injected some dangerous chemicals into the stratosphere which consume ozone and reduce its concentration.
- This causes ozone hole in the stratosphere.
- Exhaust gases from jet aircraft and artificial satellites discharge nitric oxide (NO), nitrogen dioxide (NO_2) etc. which immediately react with ozone.





- Chlorofluorocarbon (CFC) are used as coolants in refrigerators and air conditioners. In presence of UV radiation (200nm) from Sun, CFC breaks up into Chlorine free Radical (Cl') which readily consumes ozone.

The free radical (Cl') is generated and continues the chain reactions.

(* One molecule of CFC consumes one lakh molecules of ozone)

Animal husbandry

- It has been noted that cattle dung, buffalo dung and their urine are rich source of Methane, an important green house gas.
- It is essential that livestock population be brought under family planning and reduction by about 25% to keep the environment clean.

→ Soil pollution:-

- Soil is the thin layer of organic and inorganic material that covers the earth's rocky surface.
- Several factors contribute to the formation of soil from parent material. This includes:
 - i) Mechanical weathering of rocks due to temperature changes, abrasion, wind, moving water, glaciers, etc.
 - ii) Chemical weathering activities and lichens.
- The surface layer consists of freshly fallen and partially decomposed leaves, twigs, animal waste, fungi and other organic materials are known as "topsoil".
- Soil pollution is the introduction of substances, biological organisms or energy into the soil, resulting in a change of the soil quality, which is likely to affect the normal use of the soil or endangering public health and the living organisms.
- Soil pollution / pollutant have an adverse effect on the physical, chemical and biological properties of soil and reduce its productivity.

Causes of Soil Pollution :-

- ① Indiscriminate discharge and dumping of industrial effluents on land. thus, contaminates them.
- ② An increase in the use of pesticides and fertilisers for agriculture increases soil toxicity.
- ③ Open defecation by animals and human beings.
- ④ Accumulation of solid waste such as garbage and reuse products (not degraded)
- ⑤ Radioactive substances from nuclear plants are released into the soil. (emitting radiations)
- ⑥ Nitrification process takes place where nitrates are leached out from the soil by plants in the presence of nitrifying bacteria.
- ⑦ Acid rain increases the normal pH of soil and converts neutral soil to acidic soil.
- ⑧ Soil erosion causes the loss of topsoil, makes the soil less fertile and reduces its water holding capacity and also its productivity.
- ⑨ Waterlogging and Salinisation increases the soluble salts in soil and makes the soil toxic.

EFFECTS OF SOIL POLLUTION :-

- Effects on human health.
- Effects / reduces the soil productivity.
- Decomposition of organic matter by micro-organisms releases unpleasant odour.
- Contaminates ground water.
- Radioactive isotopes replace the essential elements of body and causes abnormalities.

CONTROL OF SOIL POLLUTION :-

- Effluents should be properly treated before discharging them on/into the soil.
- Solid waste should be properly collected and disposed off by appropriate method.
- From the waste, recovery of useful products should be done.
- Biodegradable organic waste should be used for generation of biogas.
- Cattle dung should be used for methane generation.
- There should be optimum use of fertiliser and pesticides.
- Bioremediation: It is a process of treatment process that uses micro-organisms (yeast, fungi or bacteria) to break down and degrade hazardous

substances into less toxic or non toxic substances (CO_2 and water)

NOISE POLLUTION

sound is mechanical energy from vibrating source, noise can be defined as an unpleasant and unwanted sound and has become a part of urban life and industrial centre in this century.

Noise is a physical form of pollutant and is not directly harmful to the life supporting system namely air, water and soil. Its effects are more directly on the receiver i.e. man.

Sound power level

Sound power is the energy rate - the energy of sound per unit of time from a sound source.

Sound power can be expressed as a relation to the threshold of hearing - 10^{-12} W in a logarithmic scale called Sound power level - L_w

$$L_w = 10 \log(N/N_0)$$

$$N = \text{sound power (W)}$$

Human hearable sound power spans from 10^{-12} W to 10^{-10} W , a range of $10^{10}/10^{-12} = 10^{13}$

Sound intensity

- Sound intensity is the acoustic or sound power (w) per unit area. The SI units for sound intensity are W/m^2 .
- The sound intensity level can be expressed as

$$L_I = 10 \log \left(\frac{I}{I_{ref}} \right)$$

L_I = sound intensity level (dB)

I = sound intensity (W/m^2)

I_{ref} = 10^{-12} reference sound intensity (W/m^2)

Sound pressure level

It is the pressure in the force of sound on a surface area (m^2) perpendicular to the direction of the sound. The SI units for the sound pressure are N/m^2 or Pa .

The sound pressure level

$$L_p = 10 \log \left(\frac{P^2}{P_{ref}^2} \right) = 10 \log \left(\frac{P}{P_{ref}} \right)^2$$

$$= 20 \log \left(\frac{P}{P_{ref}} \right)$$

L_p = sound pressure level (dB)

P = sound pressure (Pa)

$P_{ref} = 2 \times 10^{-5}$ reference sound pressure

Sources of Noise pollution:-

- Industrial operation: textile mills, printing press, metal works and engineering establishment.
- Transport vehicles: air, road and rail transportation.
- House hold: electric home appliances, entertainment equipments, loud conversation, moving of furniture.
- Celebrations: social / religious functions, elections, demonstrations and commercial advertising.
- Agricultural Machines: tractors, threshers, harvesters and tube wells.
- Construction: Noise from construction equipment is a major source of noise pollution like mixers.
- Defence equipment: Tanks, launching of rockets, explosions, exercising of military airplanes, shooting practices, screams of jet engines and sonic booms.

Effects of Noise pollution

- Exposure to sufficiently intense noise for a long duration results in permanent damage to the delicate tympanic membrane or the ear drum.
- Noise can also cause some physiological effects like headache by damaging blood vessels of the brain, cardiovascular and gastric effects.
- Muscular strain and nervous breakdown.
- It can disturb sleep, problems in communication.

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- Lack of concentration.
- Efficiency of the person is reduced.
- Noise affects the quality of life.

Control of Noise pollution

- Noise pollution could be controlled by either reducing the noise at the source or by preventing its transmission or by protecting the receiver.
- Reduction in sources of noise.
- Proper Oiling will reduce the noise from Machinery.
- Use of sound absorbing Silencers.
- Through laws.
- Decib.

Solid Waste Management:

All solid and semisolid waste arising from human and animal activities, except human excrete and liquid waste from bathroom and kitchen, those are discarded as useless and unwanted, are included in the terms of solid wastes.

Solid waste can be classified as municipal, industrial, medical, mining waste and sewage sludge.

Municipal solid waste: It consists of household waste, construction and demolition debris, sanitation residue and waste from streets. This garbage is generated mainly from residential and commercial complexes.

Hospital waste: It may include wastes like Sharps, soiled waste, disposables, anatomical waste, discarded medicines, chemical wastes etc. cultures, in form of disposable syringes, swabs, bandages, body fluids, human excreta etc.

Industrial waste: They include chemicals, paints, sand, metal ore processing, fly ash, sewage treatment sludge etc. Manufacturing industries produce wastes which are solid or semisolid. These wastes can be self igniting, explosive, toxic or radioactive.

→ Agricultural waste: These include farm animal manure, crop residue etc. Animal and vegetable waste contain valuable minerals and nutrients. Humus from agricultural wastes contains nitrogen, phosphorus, potash and trace elements which are vital to the fertility of the soil and optimum plant growth.

Causes of Solid waste:-

- The main causes for the rapid growth in the quantity of solid waste are
- i) Overpopulation: Due to increasing industrialization and population large quantities of solid wastes are being generated in different forms such as solid, liquid, sludge and gases. Each city produces tonnes of solid wastes daily from households, offices, industry, market centers etc., hospitals, Some of these are biodegradable and some are non-biodegradable and Hazardous waste.
 - ii) Urbanisation: Due to pressure of urbanization, most of the cities are growing fast and sometimes they develop beyond the planned. Earlier waste disposal did not pose problem due to less population and lack of public awareness. But due to rapid urbanization, proportionate increase in domestic and industrial solid waste generation was observed.

in Large cities.

iii) Technology: With the development in technology, there is a shift from natural goods to the artificial ones, those are generally non biodegradable by nature such as plastic, DDT etc. These are largely responsible for causing solid waste pollution.

EFFECT OF SOLID WASTE:

- ⇒ Hazardous solid waste are injurious to human health. Some have acute effects while others pose a health hazard after prolonged period of exposure. Improper disposal of such waste has resulted in the death of human and animals through contamination of crops and water supplies.
- ⇒ Solid waste ~~disposable~~ disposal increases the rate of breeding of disease vectors, primarily flies and rats.
- ⇒ There is danger of water pollution when the leachate from a solid waste dump enters surface water and ground water resource.
- ⇒ In addition, uncontrolled burning of open dumps can cause objectionable odour and air pollution.
- ⇒ Improper handling of solid waste causes damage to the environment. Uncontrolled dumping of urban waste destroys the beauty of the country side.

Management of Solid Waste

- Some of the waste can be recovered and reprocessed a procedure commonly known as recycling. However, before the waste can be disposed of effectively, they must be collected efficiently. These activities i.e., collection, disposal and recovery are known as solid waste management.
- Four R's (Refuse, Reuse, Recycle and Reduce) to be followed for waste management.
- i) Refuse:- Instead of buying new containers from the market, use the ones that are in the house.
 - ii) Reuse:- Soft drink cans or the bottles, can be used as pencil stands or small vases.
 - iii) Recycle:- Segregate your waste to make sure that it is collected and taken for recycling.
 - iv) Reduce:- Reduce the generation of unnecessary waste: e.g. Carry your own shopping bag when you go to the market and put all your purchases directly into it.

Control Measures:-

Solid waste management involves many activities.

Collection of Solid Waste:-

- The essential parts of the overall solid waste management programme are effective collection and transport.
- The waste is delivered to fixed storage bins usually built from concrete blocks to the location from where the collection vehicle will ultimately transport it to the site of disposal.
- Collection is essential because the organic matter in the waste tends to decompose rapidly in the hot climate.

Disposal of Solid Waste:-

As cities are growing in size with a rise in the population, the amount of waste generated is increasing becoming unmanageable. The local municipalities have adopted different methods for the disposal of waste - open dump, landfills, sanitary landfills, composting and incineration.

Open dumps:-

Open dumps refer to uncovered areas that are used to dump solid waste of all kinds. The waste is untreated, uncovered and not segregated.

- It is the breeding ground for flies, rats and other insects that spread disease.
- The rainwater runoff from these bumpy contaminated nearby land and water thereby spreading disease.
- They also become a source of objectionable objectionable odors and cause air pollution when the wastes are burned in order to reduce their volume and conserve space.

Landfills

- Landfills are generally located in urban areas where a large amount of waste is generated and has to be burned in a common place.
- It is a pit that is dug in the ground. The garbage is dumped and the pit is covered thus preventing the breeding of flies and rats.
- At the end of the day, a layer of soil is scattered on top of it. But this process also have problems like contamination of ground water and soil through leaching.

Sanitary Landfills:-

- Sanitary landfilling involves the disposal of municipal wastes on or in the upper layers of

the earth's mantle especially in the degraded area in the need of restoration.

- Sanitary Landfill will solve the problem of leaching to some extent, so that this process is more hygienic and built in a methodical manner.
- The advantages of a sanitary landfill, as opposed to an open dump are:
 - i) The public health problems are minimised because flies, rats and other pests are unable to breed in the covered refuse.
 - ii) There is no air pollution from burning.
 - iii) Fire hazards are minimal.
- The rate of decomposition in sanitary landfills is also extremely variable. This can be due to the fact that less oxygen is available as the garbage is compressed very tightly.

Incineration Plants:-

- The process of burning waste in large furnaces is known as Incineration. In these plants, the recyclable material is segregated and the highly combustible waste like plastics, cardboard, paper, rubber and combustible wastes like cartons, wood scrap, floor sweepings, food wastes etc. are subjected to burn at very high

- temperatures in presence of oxygen. At the end of the process all that is left behind is ash.
- During the process some of the ash floats out with the hot air. This is called fly ash.
 - Burning garbage is not a clean process as it produces tons of toxic ash and pollutes the air and water. A large amount of the waste that is burnt here can be recovered and recycled.
 - The advantages of incineration include wide range ability to handle varying loads and small space requirement for ultimate disposal.

Composting

- This waste can be recycled by the method of Composting. One of the oldest forms of disposal. It is the natural process of decomposition of organic waste that yields manure and compost, which is very rich in nutrients.
- Composting is a biological process in which micro-organisms, mainly fungi and bacteria, convert degradable organic waste into humus like substance. This finished product, which looks like soil, is high in carbon and nitrogen and is an excellent medium for growing plants.
- It recycles the nutrients and returns them to the soil as nutrients.

- Compost allow the soil to retain more plant nutrients.
- It makes the soil easier to cultivate.
- It prevents soil erosion by keeping the soil covered.
- It helps in controlling the growth of weeds in the garden.
- It helps keep the soil cool in summer and warm in winter.

Pyrolysis or destructive distillation:-

- In this disposal method, the solid wastes are heated under anaerobic conditions i.e. burning without oxygen. The organic components of the solid wastes split up into gaseous liquid and gaseous fractions (CO , CO_2 , CH_4 , tar, charred carbon).
- Pyrolysis is a highly endothermic process and that is why it is also called destructive distillation.

Land farming:-

- The organic wastes are either applied on top of the land or injected below the soil surface with suitable equipment, where they undergo bacterial and chemical decomposition.

Waste utilisation:-

- Many solid wastes generated by industries

can be utilised directly. Fly ash and bottom ash from power plants can be used commercially largely as cement substitute.

- Recycling involves the collection of used and discarded materials processing these materials and making them into new products.
- It reduces the amount of waste that is thrown into the community dustbin thereby making the environment cleaner and the air fresher to breathe.

